Please refer to the Teacher Resource document for information on how to use the worksheet for the activity.

Q1. Investigate the effect of magnets on compasses. Follow the method below, record your observations and use these observations to draw a conclusion.

Equipment: Blank page; Compass; Bar magnet; Pencil

Method:

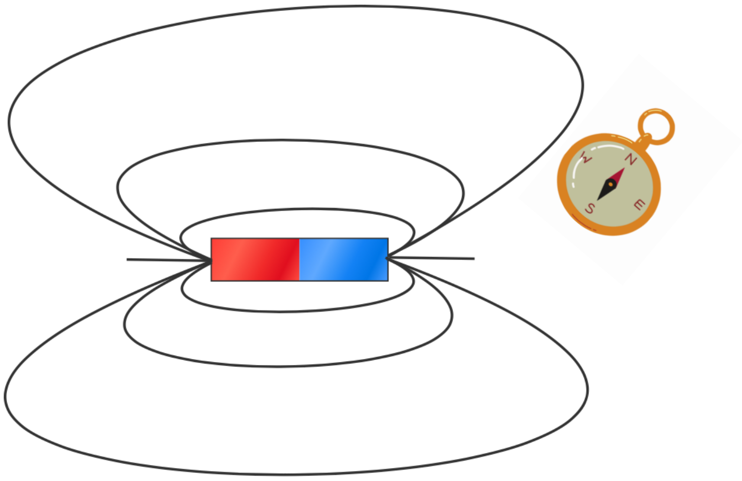
1. Place the bar magnet in the middle of the page.
2. Place the compass at one end of the magnet (North or South pole)
3. Note the direction of the compass needle and mark a dot with a pencil on the page where the needle is pointing.
4. Move the compass to the other side of the dot you have just made and note the direction of the compass needle.
5. Mark a new dot with a pencil on the page where the needle is pointing now that the compass has been moved.
6. Repeat this process until you reach the other pole of the magnet.
7. Start again on the other side of the bar magnet.
8. Move the compass further away from the magnet and repeat the method again.
9. Record your observations.
10. Sketch a diagram of the set-up.

My Observations and Diagram of Experimental set-up:

Expected Response

- The needle of the compass changes direction as the compass is moved across the page from one pole to the other.
- After connecting the dots I could see lines forming from one pole to the other. The lines traced out a semicircle shape and got wider the further I moved the compass from the poles.
- At the poles the lines all curved inwards.
- The magnet has an effect on the compass.
- One pole is in the North direction of the compass and the other pole is in the South.

Video showing set up and procedure:
Plotting Magnetic Field Lines GCSE Physics Required Practical



My Conclusions:

Expected Responses

- Magnets have a North pole and a South pole (like the Earth)
- A compass can be used to tell you if you are facing the North pole or the South pole because the compass needle is affected by the magnet.
- The compass needle is a tiny magnet - it is attracted to the North pole and deflected by the South pole.
- The effect of a magnet can be felt even from a distance away from the magnet - we can see this because the lines tell us how far the magnetic force reaches.
- The bigger the magnet the further the lines will spread out from the magnet.
- The lines have a special name: Magnetic Field lines.

Q2. Hans Christian Oersted, a physicist and chemist, conducted an experiment in 1820 to learn more about magnets. Follow the method below, record your observations and use these observations to draw a conclusion.

Equipment: 1.5V battery; Compass print out; Compasses (2 or 3); 1 copper wire; Connecting wires with crocodile clips

<u>Method:</u>

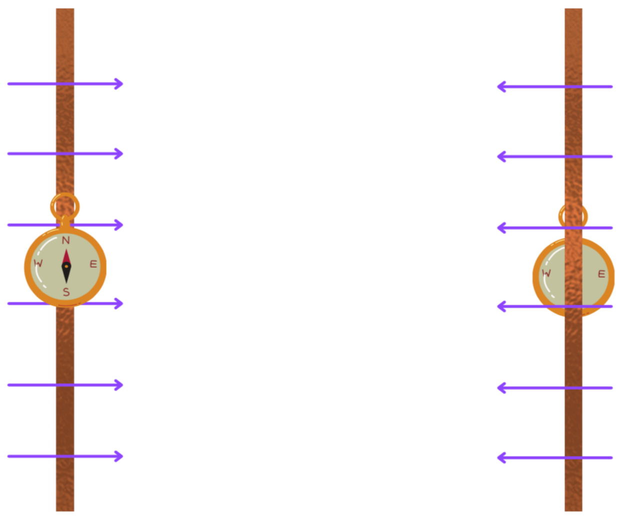
1. Place the compass print out flat on the desk.
2. Lie the compasses on top so that they are pointing North on the compass print-out. Make your first observation.
3. Connect the copper wire to the battery using the wires with crocodile clips.
4. Position the copper wire vertically and lying above the compasses.
5. Record your observations.
6. Carefully position the copper wire vertically and lying under the compasses.
7. Record your observations.
8. Sketch a diagram of the set-up

<u>My Observations and Diagram of Experimental set-up:</u>

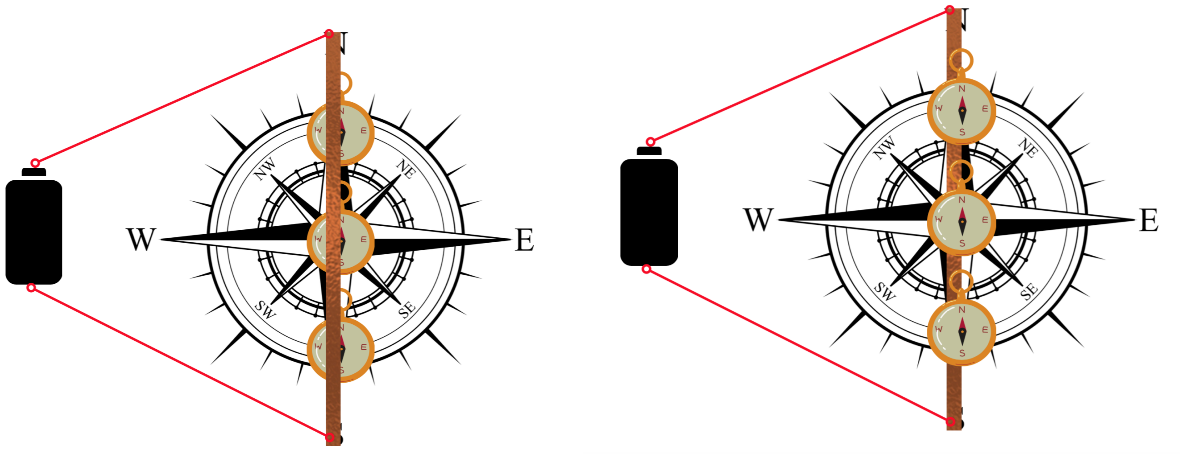
Expected Responses

- At the start, the compasses all pointed to the North pole.
- When the copper wire was connected to the battery and lying **above** the compasses, the compass needles started to move so now they were pointing to the **East** (using the paper printout compass as a guide).
- When the copper wire was connected to the battery and lying **below** the compasses, the compass needles started to move so now they were pointing to the **West** (using the paper printout compass as a guide).

(Diagram shows purple arrows indicating direction of magnetic field according to position of wire relative to compass)



Video showing set-up and procedure:
Oersted's Discovery

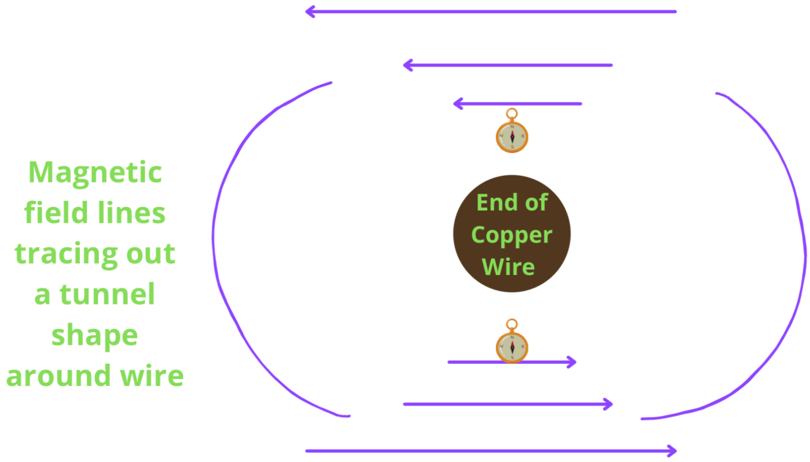


Wire above and below compasses to see direction of compass needle changing as the electric current induces a magnetic field.

My Conclusions:

Expected Responses

- Electricity has some connection to magnetism, the electricity in the wire was able to affect the magnetic needles of the compasses.
- The position of the copper wire changes the direction that the compass points.
- From the experiment in Q1. I learned that the compass points in the direction of the magnetic field. So the magnetic field is going to the East when the wire is above the compasses and it's going to the West when the wire is below the compasses.
- If you put compasses below and above the wire at the same time you would have the compasses on top pointing to the East and the compasses underneath pointing to the West. Looking down the wire this makes a circle/tunnel/loops of magnetic field lines around the wire.



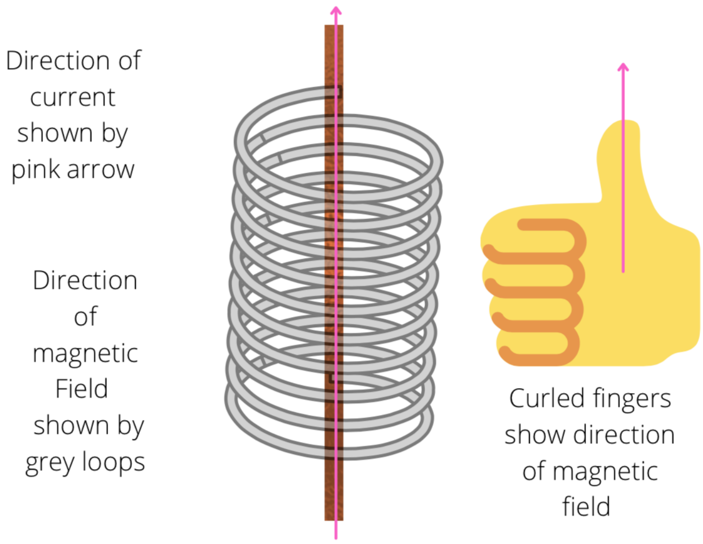
Q3. Combining what you have learned about magnets and electricity from Q1 and Q2 describe the connection (if any) that you have observed between electricity and magnetism. You may add diagrams to help explain your thinking.

James Clerk Maxwell's equations describe the relationship between electricity and magnetism, stating that where B is the magnetic field and E is the electric field:

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$

Which implies B $\propto$ E.

The flow of charge (current) induces a magnetic field in the perpendicular direction to the direction of the current.



When conducting his investigation, Oersted realised that the direction of the magnetic field depends on the direction of current in the wire. The right-hand rule is an easy way to remember the direction of current and direction of magnetic field.

Expected Responses

- These loops of magnetic field lines observed in the experiment look similar to the magnetic field line loops formed around the bar magnet in Q1.
- There is a connection between magnets and electricity; the compasses were affected by the electricity in the copper wire even without any bar magnet present.
- If you test the copper wire when it is disconnected from the battery the compasses are unchanged. This means it is the flow of electricity (current) which causes some effect that changes the compass needles.

Q4. Examine the images and apply your new knowledge about magnetism and electricity to **describe any features** you can see in the images.

Image 1 (Photosphere)

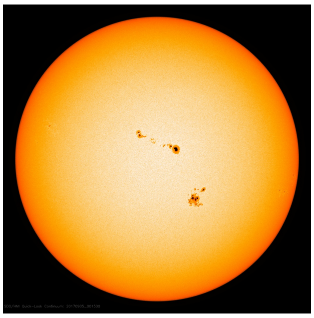


Image 2 (Photosphere)

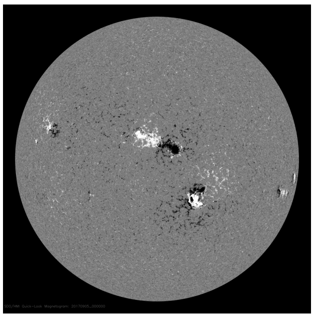


Image 3 (Chromosphere)

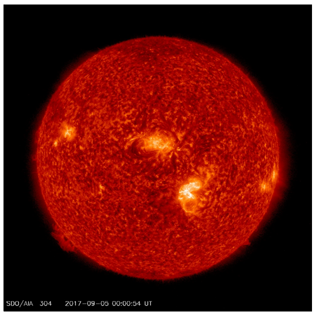


Image 4 (Transition Region)

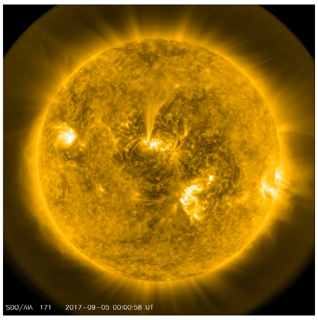


Image 5 (Corona)

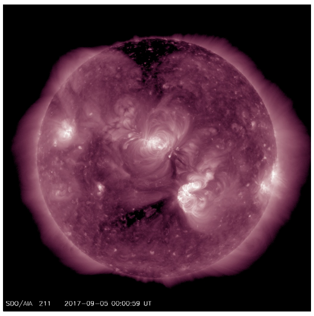
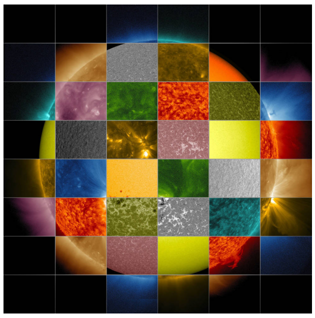


Image 6



Each image was taken on the same day but with a different type of camera, looking at a different layer of the Sun. Image 1 and 2 are the surface (Photosphere), Image 3 is the lower atmosphere (Chromosphere), Image 4 is the transition region between the lower and upper layers (Chromosphere to Corona) and Image 5 is the upper atmosphere

(Corona). Image 6 shows the whole Sun with sections taken with different cameras - this shows why the images are all different colours!

Expected Responses:

- Image 1, 2 and 3 are all showing Sunspot regions but I can't see any link here between what I have learned in worksheet 1.5 and these images.
- Image 4 and 5 have explosions or eruptions happening; I can see some loops and curves in these images that look like the magnetic field lines in the experiments in Q1 and Q2.
- In image 4 there is a halo of light coming out of the Sun, it looks like these might be magnetic field lines too that have such a large curvature that they look straight.
- Image 6 shows different bits of the Sun taken with a different type of camera. Some cameras show the loops and some do not. The loops look like magnetic field lines again.

Q5. Using everything you have learned about magnetism and electricity, what do you think would happen if you could set up the circuit and compasses from Q2. near the loops visible on the Sun (images Q4)? Would the compasses act in the same way or a different way to what you observed in Q2?

The loops visible in the images of the Sun are magnetic field lines. This means the compass would be affected by the presence of a magnetic field. The moving plasma in the Sun (charged gas particles) induces magnetic fields. The plasma is carried through the magnetic field loops in the direction perpendicular to the magnetic field loops similar to the current in the wire in Q2.

Expected Responses:

- I think the compass would follow the loops because they look like magnetic field lines. It would be the same as in Q1. when I marked out the lines using a compass and pencil. The needle of the compass would move as it moved along the loops on the Sun.
- I think if I was to mark out the lines with the compass and pencil along the loops I would trace out the loop shapes. The same tunnel/circle shape that I observed in the experiment in Q2. would be seen here as well.

Q6. In worksheet 1.4 you learned about how atoms of Hydrogen and Helium collide with each other and lose electrons (forming ions). These ions have a charge and are moving around in the Sun. How would you describe moving charges? How are the moving charges affecting the loops you can see in the images (Q4)?

The moving charged Hydrogen and Helium gas particles are called plasma. The Sun is made of plasma. The plasma is constantly moving and therefore acts in the same way as electricity. The moving plasma induces a magnetic field that can be seen under certain wavelengths of light.

Expected Responses:

- Moving charges are called current.
- The charges are affecting the loops in the images of Q4. the same way that the current in the copper wire affected the magnetic field in the experiment in Q2. The current caused a magnetic field which was detected by the compasses. So the charged gas particles moving around in the Sun must be causing a magnetic field too, and that's what the loops that we can see in the images are.